

## ENHANCING QUALITY OF SERVICE: A CONCEPTUAL POKA-YOKE APPROACH

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### ABSTRACT

*Vending machine is one of the most widely used machines by the consumer. Many improvements have been made to improve the capability of vending machines. However, there are quality issues on products dispensed by the machines. In this study, the product expiration date is the main focus. Unlike buying food from the convenience stores where the expiry date for each product is readable, consumer are able to see the product expiry date only after having paid and product dispensed by the vending machine. Hence, consumer has negative perceptions of the company producing the products and also the vending machine service providers. This study emphasizes on improving the vending machines using automatic date-based switch as a poka-yoke device to improve quality of service. Qualitative approach is conducted through interview with a service provider company operating and maintaining vending machines. The result of this study revealed that the current manual maintenance have a major flaw and by adopting the poka-yoke approach on vending machines can improve the quality of service of products dispensed by the machines. Hence, The purpose of this paper is to describe issues and the improvement to quality of service on vending machine services industry by adopting a poka-yoke approach.*

**Key words:** *quality of service, poka-yoke, mistake proofing, vending machine*

### INTRODUCTION

Vending machine is one of the most useful automation machines widely used by consumer. Many improvements have been introduced to improve the variety, capability and function of vending machines. However, there is a quality of service and assurance issues in term of products quality dispensed by the vending machines. Unlike buying food at convenience stores where consumers are able to see the expiration date for each product, consumer often used the product dispense by vending machine without being able to see the expiration date. This may cause harmful effect both to consumer and the service providers who own the machines. Consequently, consumer perceptions can affect the company and the service provided. The power of consumer to demand a quality assurance system from service providers depends on three conditions (Hughes & Williams, 1995):

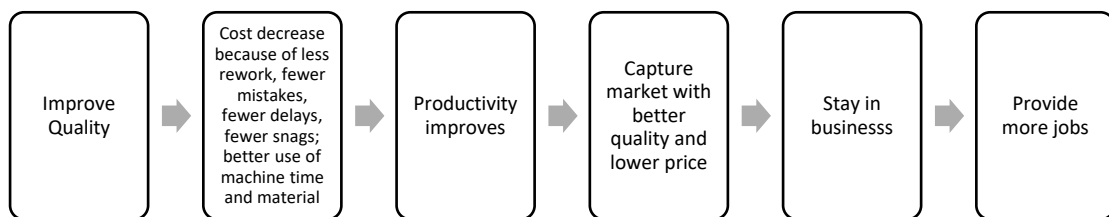
- there must be access to capable service providers so that consumer can transfer its purchases from an unsatisfactory service provider to a better one;
- the consumer must buy a significant proportion of a service providers' sales;
- the consumer must have the capability to operate the system.

The primary reason for consumer using its power to impose a quality assurance system is to force service providers to deliver products that conform to specified requirements right the first time (Groocock, 2000), and without jeopardizing consumer's health, safety and other rights.

This research has two main objectives; (i) to investigate the current process of operating of vending machines in public premises, and (ii) to suggest the possible modification to vending machines by implementing date-based automatic switch as the poka-yoke a.k.a. mistake-proofing device, to improve quality of service and assurance. Poka-yoke techniques are approaches to prevent mistakes or errors (Jamaludin & Young, 2005). Hence, its main purpose is to remove the possibilities of making mistake that may cause substantial damage (Fisher, 1999).

## LITERATURE REVIEW

According to Deming (Moen, Nolan & Provost, 1991), an organization that focuses towards improvements of quality, reduces cost and higher productivity will result in a chain reaction as shown in Figure 1 below, where the organization will increase their market share through lower cost and better quality which subsequently, will sustain them in business and provide more jobs opportunities.

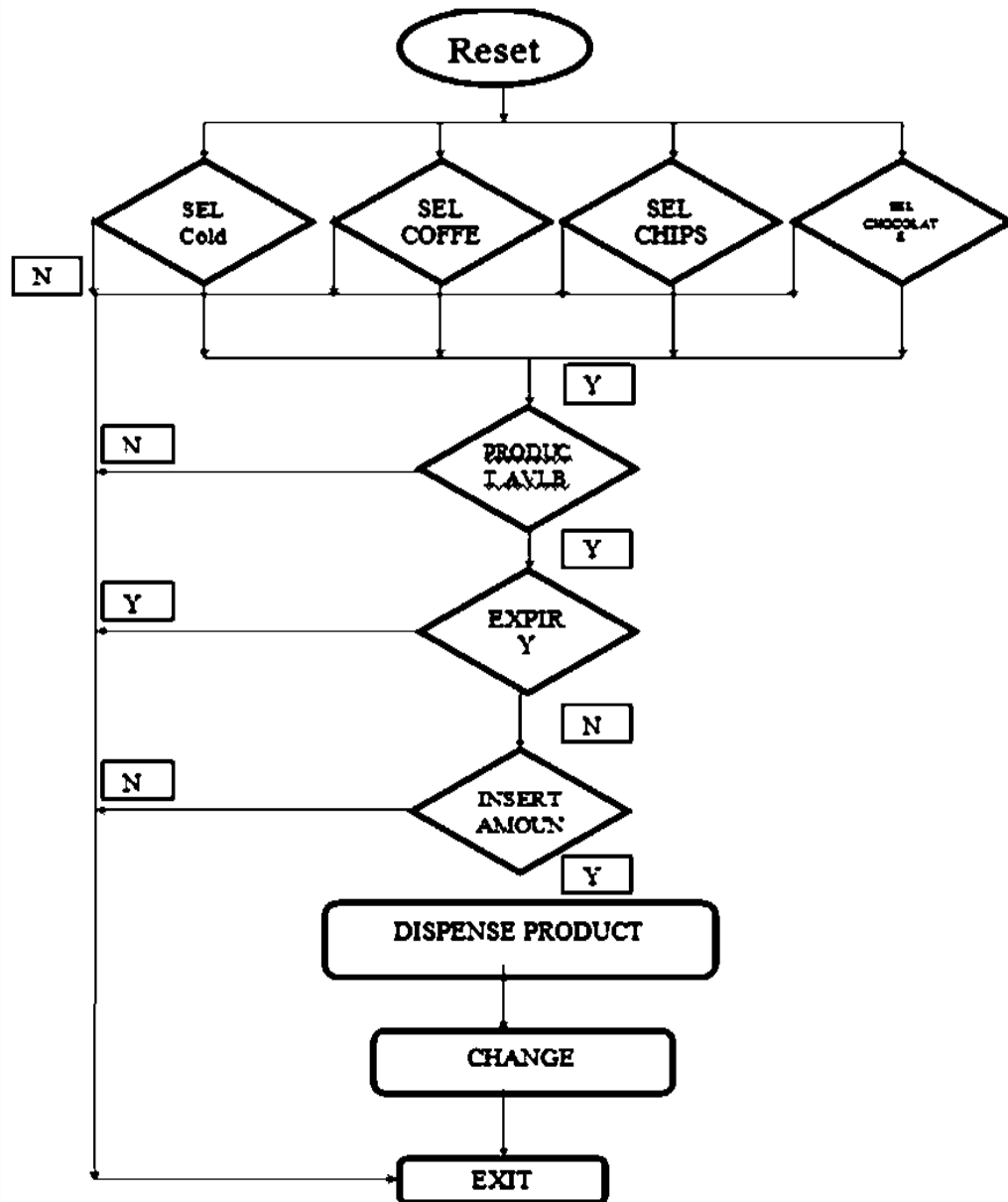


**Figure 1**  
Deming's quality and productivity chain reaction (Moen, et al., 1991)

To achieve better quality, organization must at all cost avoid producing poor quality products, such as product with defects, and implement ways to ensure only quality products reach the consumer. Shingo (1986) stated, *"The causes of defects lie in worker errors, and defects are the results of neglecting those errors. It follows that mistakes will not turn into defects if worker errors are discovered and eliminated beforehand. Defects arise because errors are made; the two have a cause-and-effect relationship. Yet errors will not turn into defects if feedback and action takes place at the error stage"*. Hence, Shingo introduced the concept of Poka-yoke to ensure defects are avoided and only quality products reach the consumer. Poka-yoke or mistakes proofing techniques are among the first response to manufacturing process control (Shimbun & Hirano, 1988) especially when new product improvement and process is required in ensuring the quality (Jamaludin & Young, 2005, Jamaludin, 2008, 2013).

This study looked into the stock management of beverage products stored in vending machines. Stock management includes monitoring of quantity and physical level of stocked items (Yalaoui, 2012). Typical vending machine service providers usually

check the quantity but seldom maintain or rarely check each item's expiration date. One study was done on mistake proofing for vending machines that dispensed expired product (Suhail, Beg & Mohammad, 2014). They conducted the study to design an Automatic Dispensing Machine with expiry date features by using Finite State Machine Model. They created a Flow chart of how the machine will work as shown in Figure 2.



**Figure 2**

Automatic dispensing machine flow chart (Suhail, Beg & Mohammad, 2014)

When a consumer selects one product, the machine will firstly check whether the selected product is available in the machine. Next, the control unit will check the product expiration date. If the product is not expired, then the machine instructs the consumer to insert sufficient money. This design prevents the machine from dispensing expired products through sequential procedure involving expiry date as

feedback. To implement this method requires modification on the whole machine system and circuit board.

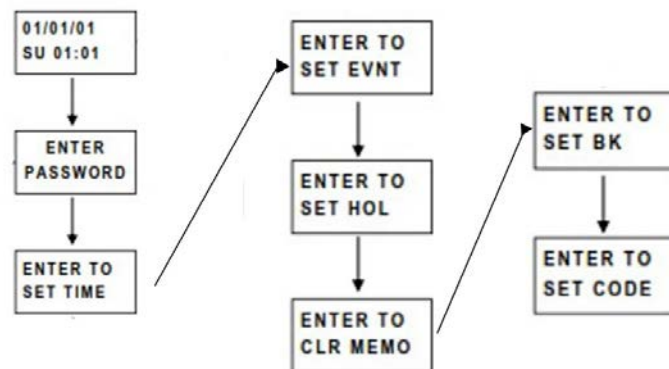
To adopt the poka-yoke approach, this study used a time-based device. An automatic date-based switch device that can be set to operate two relays for the whole year non-stop, example of the device is shown in Figure 3 below. It has the capability of setting at required date and time. The device is design to be applied in many applications such as lighting, security, environmental control, access control, etc.



**Figure 3**

Automatic date-based switch (<http://www.affordableopeners.com/sa-027q.html>)

Figure 4 shows the schematic process of the time-based device, typically with a simple and easy to set time, day, date, and password features.



**Figure 4**

Flow Chart for Device Setup (source: SECO-LARM, Inc.)

## METHODOLOGY

This study undertook a qualitative research through a descriptive case study, which investigates the occurrence of a phenomenon (Taylor & Bogdan, 1998; Shields & Rangarjan, 2013). Data or evidences are collected from interviewing the expert i.e. the person managing the vending machine operation at a premise where this study is conducted (the name of vending machine operator and the premise are kept anonymous). With a very limited time frame, only one vending machine operator and one premise were being studied and investigated. However, the operator delivers and maintains various types of canned, boxed and bottled drinks' in vending machines placed at strategic location through out the premise.

Structured and open-ended questionnaires are designed for the interview in expectation for a free flow of responses. Among the queries are; availability of databases pertaining to type of product sold, product expiry dates and disposal process, replenishment procedures, complaints and solution, and maintenance. Due to confidentiality, certain data and statistics will not be shown and describe as requested by the vending machine service provider.

In addition, a Cost-Benefit Analysis (CBA) is used as an analysis tool to describe the economic efficiency and implication when adopting the poka-yoke device. The advantage of using CBA is that it gives a comprehensive overview of all effects from a change that is going to be implemented (Nordic Council of Ministers, 2007) and as a decision support tool to assist in providing the best information about the subject in question and the learning process.

## DATA ANALYSIS

There are three types of vending machines based on the product sold i.e. Canned/boxed/bottled products' machine, hot/cold products machine, and snacks machine. Figure 5 shows a typical beverage vending machine available at public premises. Canned and snack machines are easier to maintain because they require conventional way of stocking, replenishment and maintenance. However, hot and cold beverage machines are operationally unique. Hot and cold beverage stocking, replenishment and maintenance cost are much higher as compared to the other two types. Unlike canned or snack machines, the hot and cold beverage machines require more attention on hygienic care of the product and the machine, and the complexity of the mixture of ingredients dispensed by the machine.



**Figure 5**  
Typical vending machines: canned/bottled (left) and hot/cold (right) drinks.

## **Discrepancies in Quality of Service**

Although vending machines are automated devices widely used as at point-of-sales, but they still face a lot of problems and issues. In an interview with a service provider, vending machines do not have their database system to store information embedded in the machines. This makes it difficult for the service providers to trace what actually goes on in the machines. Hence, it is difficult to track the machine condition, product sold, product balance, etc.

Additionally, there are complaints from consumers regarding the quality of service with regards to mechanical error, device faulty, poor maintenance, etc. For example, the machine fails to dispense product after the money is already inserted, or the hot and cold machine dispenses only water when it runs out of product raw material (coffee powder, ice, sugar, creamer, etc.), and most importantly, machines dispensing expired products.

Except the expired products dispensed by the machines, most errors or discrepancies are caused by the machine's mechatronic system and its operation. For example, in most cases after the costumer inserted the money; the machine failed to dispense the product. Even though consumer complains, the service providers could not do anything to refund their money because there is no evidence to support the complaint. Vending machines do not issue receipt (as a consequence of lacking this function), therefore it is difficult for consumer to report to the service providers or the authority for refunds or even to sue them.

Unlike the other two common problems, the error of disposing expired products could be prevented by poka-yoke or mistake proofing approach. The action of dispensing expired product happens because of discrepancies in the stocking, replenishment and maintenance practices in the industry.

## **POKA-YOKE APROACH TO PROBLEM SOLVING**

Poka-yoke approach is adopted in analysing and resolving the issue surrounding the vending machine service provider. The approach involves identifying the root cause of the problem; identifying where the problem appears; finding the appropriate method, cost saving and permanent solution; defining the type of solution to be implemented, and describing the key improvement from the selected solution. The list below is a simplified breakdown of the analysis:

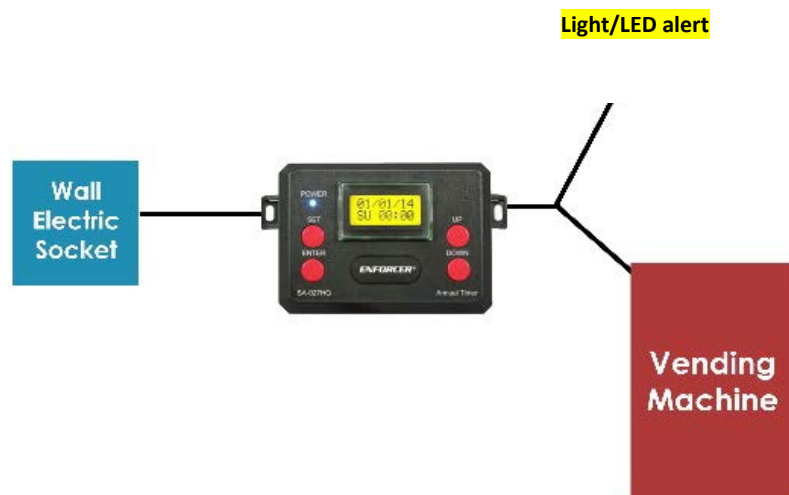
- Problem : Machine dispensing expired product
- Process : Prevent dispensing expired product
- Solution : Adding automatic date-based switch and light/LED indicator
- Type of Poka-yoke : Preventing error
- Key Improvement : Machines are guaranteed not to dispense expired product

Hence, a discrepancy in quality of service has been detected i.e. the vending machine dispenses expired products and the appropriate solution is presented. Table 1 below describes the selected solution reasoning available in the market, i.e. adopting an automatic date-based switch and the way it functions.

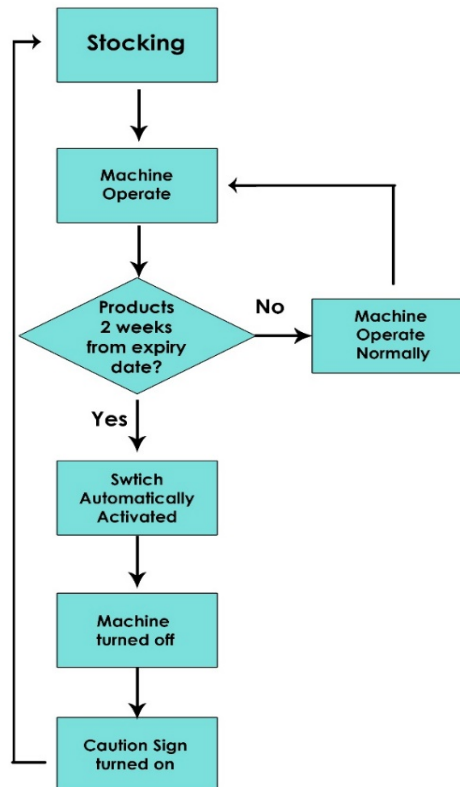
**Table 1**  
Hypothetical poka-yoke solution

Description of Process : By using automatic date-based switch as trigger to cut power at certain date that already set before. When the power cut off then the LED will turned on.	
Before Improvement	After Improvement
<ul style="list-style-type: none"> <li>- There is no prevention system to prevent consumer accessing expired product dispensed by the machine.</li> <li>- The quality control relying on manual checking for each product expiry date.</li> </ul>	<ul style="list-style-type: none"> <li>- There will be an indicator to alert both consumer and service provider that the product inside the machine has expired. The indicator will be : <i>"Sorry the machine is currently out of use"</i>.</li> </ul>

The automatic date-based switch (as a poka-yoke device in preventing errors) is connected to the wall power source, the warning light and the vending machine (see Figure 6). As shown in Figure 7, the process is changed from previous method that relies on manual inspection to check for stock and product expiration dates. All products stored are of the same expiry date and not mixed with other expired ones. This can easily track and check the current status of the product. Then, set the automatic date-based switch according to the specified date prior to products expiry date. Subsequently, the machine will be turned off by the automatic date-based switch and trigger the warning light. The service providers begin the replenishment process by replacing all the soon-to-be expired products to new ones, and the cycle continues. Hence, consumers are guaranteed the products from the vending machine are valid for consumption.



**Figure 6**  
Installing an automatic date-based switch to a vending machine.



**Figure 7**  
Poka-yoke implementation flow chart

### Cost-Benefit Analysis

The CBA breakdown in implementing the poka-yoke system is as follows:

1. Implication on consumers

The perceived effects on consumers is the improvement to quality of service which ensures that the consumers receive value for the money paid, and warranty of products dispensed by the machine will always be in good condition and no expired products. Furthermore, consumers can finally know the current condition of the product (and vending machine) only by looking at the indicator/warning light.

2. Implication on the service providers

Huge financial and public relations implication to the service providers after removing the chance of consumers accessing expired product, complaints, potential of lawsuits and health issues related to consumers' satisfaction towards product quality. In addition, the service providers can reduce the cost of maintenance and stocking of products without risking the machine dispensing expired products.

## CONCLUSION

This study has achieved the two main objectives: (i) analyze the current process of operating vending machines by a service provider; and (ii) proposing the use of automatic date-base switch as a poka-yoke device on vending machines in public



premises. The current process of maintaining the vending machine has major flaw, however which can be resolved to avoid potential lawsuits related to consumer satisfaction towards product quality and quality of service. By using poka-yoke approach to the solution (the flaws could be fixed with the automatic date-based device installed at vending machines), a prevention technique so that machines would not dispense expired products. Although, this study was conducted based on analysis and feedback from the service providers with no simulation or real life implementation, the poka-yoke approach has shown that there is a possibility to deliver and improve the quality of service and quality assurance on the vending machine industry. Further research is suggested to explore other aspects of quality of service in other types of machines by applying the same approach.

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